BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY

SYNOPSIS ON

STUDIES ON PLANKTON AND ICHTHYOFAUNAL DIVERSITY IN RELATION TO WATER QUALITY ASSESSMENT IN SOME OF THE PERENNIAL LENTIC WATER BODIES OF COAL-BEARING AND NON COAL-BEARING REGION OF DISTRICT DHANBAD, JHARKHAND.

For

DOCTOR OF PHILOSOPHY

IN

FACULTY OF SCIENCE (ZOOLOGY)

UNDER THE SUPERVISION OF

DR. SHAILENDRA KUMAR SINHA

HEAD, UNIVERSITY DEPARTMENT OF ZOOLOGY

B.B.M.K. UNIVERSITY, DHANBAD (JHARKHAND)

DHANBAD – 828130

SUBMITTED BY

SHARMILA KUMARI

Introduction:

Three quarters of the earth's surface occupied by water. Only about 1% of earth's water is available on land in the form of fresh water ecosystem for different purposes [1]. These fresh water ecosystem forms an essential pre-requisite for all the living organisms on the earth. These natural fresh water resources and the biodiversity of the aquatic ecosystem have been destroyed by human activities to fulfill their domestic and industrial needs that lead to various changes in the trophic levels eventually causing pollution to the system.

In the last few decades, on account of rapid urbanization and industrialization, there has been an enormous pressure on the demand of fresh water [2, 3]. Mining activities threatens the quality and amount of surface and ground water assets in numerous parts of the world [4, 5, 6, 7, 8]. Water contamination in mining regions is predominantly because of overburden dumps, surface impoundments, mine water, industrial effluents, acid mine drainage, tailing ponds, etc. [2].

The surface water bodies in coal-bearing areas, includes mining exercises like, acid mine drainage, overburden dump, untreated mine sewage water, which disintegrate the water quality. On the other hand, in non coal-bearing areas, the water bodies are not affected by the industrial and above mentioned mining activities at all. But these water bodies get deteriorated as well due to indecent human activities like bathing, washing, and solid waste dumping; receive sewages from the houses etc. These mining, industrial and local activities actually enhance the organic content or pollutant load of water bodies which leads to the depletion of the aquatic floral and faunal diversity.

Functional parameters of an ecosystem ascribes to the ecological significance and resulting from the interaction between its physical, chemical and biological components. These interactions bring about the creation of an assortment of niches which are inhabited by various organisms, thus, providing a habitat for plants, animals and microorganisms in an ecosystem and thus determine the tropic dynamics of the aquatic body for its proper fish production [9]. There is direct relationship between the biodiversity and the status of water quality. Water contains nutrients, which can invigorate the growth of the plankton population, great amount of organic and inorganic matter, which influence water quality of the pond [10]. Many studies have revealed that, phytoplankton and zooplankton can be used as indicators of water pollution [11].

When an aquatic system is considered, the planktons prove to be an indicator that gives a quick response towards the changes in the ecosystem [12, 13].

Phytoplanktons, the producers are the first trophic level of an aquatic food chain, are followed by the zooplanktons as the next trophic level and finally integrated into the fish population. Maintenance of good water quality and decent varieties of planktonic population is of primary importance that can enhance the fish production. Fish culture seems to be one of the best sources of economy that helps in the upliftment of local people's sustainability. Deterioration of water quality and biodiversity exhaustion attracts deep concern towards our aquatic environmental condition. Water quality analysis and standard strategies are very useful to understand the water pollution stress and status of biodiversity.

The selected water bodies are situated in the coalfield and the residential area of Dhanbad. Dhanbad is famous for its coalmines and industrial establishments and one of the largest coal beds in India. Dhanbad is rich in having number of lentic water bodies. These water bodies scattered in different area of this city. Some of these are affected by the coalmines and some are situated in the non coalfield area. The aquatic ecosystem and the quality of ponds of this city disturbed by the domestic sewages, industrial and coal mining discharges, etc. The selected ponds also influenced by aforesaid indecent activities which result into nutrient enrichment.

Nutrient increase is directly incorporated into the plankton community and finally into the fish biomass. Plankton biomass and composition in shallow water bodies fluctuate as a reaction to several interacting driving forces which may include polymixis, water level changes, weather conditions, nutrients loading and feeding management [14].

The present investigation will be carried out to evaluate the physico-chemical and biological parameters of chosen water bodies of coalfield and non coalfield area of Dhanbad, Jharkhand.

Literature Review

1. According to [15] high physico-chemical parameters value and some phytoplankton organisms (like *Closterium acerosum, C.dianae, C. lineatum, Anabaena aequalis, Navicula membranacea*), of the Chinnapperkovil pond indicate its meso-eutrophic nature

than Nallenchettipatti pond which indicates fair amount of organic substance and some specific phytoplankton species like *Merismopedia glauca* and *Fragilaria oceanica* indicates its oligo-eutrophic nature of the pond. They found out these ponds already reached eutrophication level.

2. According to one of the study carried out by [16] the mine water of the Raniganj coalfield is mildly acidic to alkaline. The value of physico-chemical parameters shows relatively higher values, which would make them unsafe for drinking. However, high salinity and alkali hazard (SAR), Mg and Na, restrict their use for irrigation. Suitable water treatment and soil management strategies are needed for their utilization for different purpose.
3. The presence of pollution indicating genera of planktons like *Navicula, Phacus, Oscillatoria, Anabaena, Euglena, Rotifers, Cyclops* etc signifies the deteriorated quality of the lakes [17]. Eutrophication of lakes due to the increased population, encroachments in and around the lakes and untreated domestic and municipal waste water [17]
4. A geochemical study of mine water carried out by [18]**,** suggest that higher concentration of electrical conductivity, total dissolved suspended, sulphate total hardness in mine water that makes it unsafe for drinking purposes that could lead to serious health problems. The mine water is also dominated by major cations and anions (like magnesium, calcium bicarbonate and sulphate) which require an effective water management and treatment for domestic purposes.
5. According to [19] the higher value of Water Quality Index (WQI) of six mine water samples varies from 26.79 to 19719.84 were examined on the basis of 13 physico-chemical (pH, Turbidity, DO, BOD, Electrical conductivity, Hardness, magnesium, chloride, calcium, nitrate, sulphate, TDS, Iron) parameters. [19] also concluded that all these mine water samples collected from the district of Sonebhadra and Singrauli of Uttar Pradesh and Madhya Pradesh, were not suitable for any domestic and industrial purposes.

Problem to be Investigated

In the proposed thesis, we aim to investigate the following problems:

- To determine the physico- chemical nature of selected water bodies.

- To determine the qualitative and quantitative analysis of planktons (Phytoplankton & Zooplankton).
- To study the fish diversity of picked water bodies.

Objectives of the Research:

- To study the present status of water quality and faunal diversity (planktons/ fish diversity).
- To study the status of pollution stress of the chosen water bodies.
- To study the impact of mining activities on water quality status and biodiversity of chosen ponds of coalfield area as compared to chosen water bodies of non coalfield area.
- To suggest remedial measures to improve the water condition of the selected water bodies.

Hypothesis:

The natural aquatic resources have unique physical and chemical properties that are extremely essential to every living creature especially to the mankind. But due to various anthropogenic activities, such as effluents from household utilization, coal mines and industries, which cause deterioration of water quality that prompts the depletion of aquatic floral and faunal diversity. This study will help to understand the occurrence and abundance of plankton and fish diversity and their dependence on the physico-chemical factors of water bodies. The present work is intended to investigate the comparative study of the physical & chemical factors and faunal diversity to comprehend the basic difference about the nature and the status of the water quality between the selected ponds of coal-bearing and non coal-bearing areas of city Dhanbad.

Research Tools & Methodology:

I. Study Area

Four sampling sites will be taken out of which two sampling sites are located in the Jharia coal-bearing area while the other two located in non coal-bearing area of the district Dhanbad. These sites are:-

1. Raja Talab
2. Karbala Talab

Coal-bearing Area

3. Bartaand Bandh Pond
4. Pandey Pond

Non Coal-bearing Area

- Raja talab and Karbala talab situated in coalmining area of BCCL at Jharia. Jharia is situated between latitudes 23° 39′N and 23° 48′N and longitudes 86° 11′E and 86° 27′E. These ponds are highly polluted and are extremely utilized by nearby individuals.
- Bartaand bandh pond (Mandal bandh) situated near CIMFR (CSIR), between 23° 48′ 49″N latitude and 86° 25′ 58″E longitude. Pandey pond (Dulal pond) situated behind Krishi Bazaar Samiti, Barwadda, between the latitude 23° 50′ 50″N and longitude 86° 25′ 33″E. These ponds are not affected by mining activities but highly used by local residents for the purpose of washing of clothes, bathing by locals as well as by domestic animals and receive dumps from the nearby houses.

Excessive interference by local residents and mining activities actually deteriorated the health of these ponds and are followed by destruction of natural floral and faunal habitat.

II. Sample Collection

Water samples would be collected from the above mentioned water bodies for further examination of physico-chemical analysis, plankton's (Phytoplankton & Zooplankton) and Ichthyofaunal diversity. The physico-chemical analysis will be done monthly while the ionic study will be done quarterly. Study of Plankton's and fish diversity analysis will be performed in pre-monsoon (summer season), monsoon (rainy season), and post- monsoon (winter season).

III. Laboratory Methods

Physical analysis of water sample

1. Temperature: By digital thermometer.
2. Turbidity: By Secchi disc technique.
3. Light penetration: By Secchi disk technique.
4. Electrical conductivity: Digital conductivity meter.

5. Total dissolved solids: Standard methods according to [20].
6. Total suspended solids: Standard methods according to [20].

Chemical analysis of water sample

1. pH: By digital pH meter.
2. Total alkalinity: Titration method according to [20].
3. Dissolved Oxygen: Winkler's method or Iodometric method according to [20].
4. Carbon Dioxide: Sodium Hydroxide method according to [20].
5. Biochemical oxygen demand: Dilution standard method [20].
6. Chemical oxygen demand: Standard method according to [20].
7. Total Hardness: EDTA Titrimetric methods [20].

Major Cations

1. Sodium (Na^{+}): Flame Photometer [20].
2. Potassium (K^{+}): Flame Photometer [20].
3. Calcium (Ca^{++}): Atomic Absorption Spectrophotometer [20].
4. Magnesium (Mg^{++}): Atomic Absorption Spectrophotometer [20].

Major Anions

1. Chloride (Cl^{-}): Mohr's Titration Method / Argentometric Method [20].
2. Nitrate (NO_3^{-}): Nitrate Electrode Method/ Phenol Disulphonic Acid (PDA) Method [20].
3. Phosphate (PO_4^{3-}): Stannous Chloride Method/ Vanadomolybdophosphoric acid Method [20].
4. Sulphate (SO_4^{2-}): Gravimetric Method [20].

Analysis of Biological Components of Water

1. Qualitative analysis of Planktons (Phytoplanktons & Zooplanktons): water sample will be collected by using bolting cloth plankton net of 50 cm diameter from the selected water bodies. The sample will be examined by fixing in the 5% formalin for Zooplankton and Lugol's solution for Phytoplankton [20].
2. Identification of Planktons by the key provided: [21, 20].

3. Quantitative analysis of Planktons (Phytoplankton and Zooplankton) diversity : Sedgwick Rafter Technique
4. Study of Fish Diversity: [22, 23]

Statistical Analysis

1. To study the correlation and test of significance of various factors of chosen water samples will be done.
2. Statistical tool SPSS will also be used to confirm the correlation between various factors.
3. To study the indices of species diversity of Zooplankton, Phytoplankton & fish diversity will be done by the help of Shannon-Weaver index, Simpson's Diversity index and Sorensen Community Similarity Index.

Significance:

Contaminants, whether mining, industrial or domestic waste, adversely affecting the aquatic health of the selected area of study. Lack of general awareness and poor water management also makes it difficult for the local people to understand and deal with this challenge.

The proposed work will help to understand the present status of water quality and faunal diversity of selected water bodies.

Fish culture is an important source of food & income for the local people. The study of ichthyofaunal diversity and with proper water management and by increasing knowledge & awareness towards the importance of surface fresh water reservoirs will enhance the conditions of water quality status and the biodiversity, which is followed by the upliftment and enhancement of the social & economic conditions of local people.

Future Prospect of the Study:

1. This study will give a better understanding towards the importance of natural aquatic resources and their faunal diversity (planktons/ fish diversity).
2. With proper water management & pisciculture will enhance the livelihood of the local individuals.

3. If the fish diversity show a decline or polluted status of the pond, remedial measures could be suggested to improve the water condition of the said pond.

Limitations:

The present work has its own limitations which may include:

- Sample or data biasness during the sample collection.
- Statistical tools and laboratory methods may have limitations or errors.
- Observable investigations require different laboratory resources.

Tentative Chapterization:

Chapter I: Introduction

This section will give an introduction to the work completed during the research period.

Chapter II: Literature Review

This will provide the reviews of the published research works.

Chapter III: Methodology

In this section, will give a detailed account on the study area, sample collection & laboratory methods (water quality parameters & plankton & ichthyofaunal analysis).

Chapter IV: Results & Discussion

Monthly & quarterly analyzed water quality parameters and seasonal analyzed faunal diversity will be mentioned in this chapter. This chapter will also include the correlation of various factors of chosen aquatic bodies.

Chapter V: Concluding Remarks

This chapter will include the concluding remarks which will make on the basis of the study.

Chapter VI: References/ Bibliography

Here, we will mention the references that will be cited.

Chapter VII: Appendices

This section will include photo plates, maps, list of acronyms & symbols.

References:

[1]. Ranee J.S. and Vasantha S. (2010). 'Physico-chemical Analysis of Bore Well Water Samples of Anaiyur area in Madurai District, Tamil Nadu, India'. *J. Curr. Sci.* 15 (2) : 403-408.

[2]. Singh P, Tiwary A.K, and Singh P.K (2014): 'Hydrochemical Characteristic and Quality Assessment of Ground Water of Ranchi Township Area, Jharkhand, India'. *Curr World Environ* 9(3): 804-813. Doi: 10. 12944/CWE.9.3.30.

[3]. Chandra S, Singh P.K, Tiwary AK, et al. (2014): 'Evaluation of Hydro-Geological factor and their Relationship with Seasonal Water Table Fluctuation in Dhanbad District, Jharkhand, India'. *ISH J Hydraul Eng* (2): 193-206. Doi:10.1080/09715010.2014.1002542.

[4]. Choubey V.D (1991). 'Hydrological and Environmental Impact of Coalmining, Jharia Coalfield, India'. *Environ Geol*. 17:185-194.

[5]. Allen S.K, Allen J.M, and Lucas S. (1996). 'Concentration of Contaminants in Surface Water Samples Collected in West-Central Indiana Impacted by Acid Mine Drainage'. *Environ Geol* 27:34-37.

[6]. Gupta D.C. (1999). 'Environmental Aspects of Selected Trace Elements Associated with Coal and Natural Waters of Pench Balley Coalfield of India and their Impact on Human Health'. *Inter J Coal Geol*. 40:133-149.

[7]. Tiwary R.K (2001). 'Environmental Impact of Coal Mining on Water Regime and its Management'. *Water Air Soil Pollut* 132:185-199.

[8]. Khan R, Israili SH, Ahmed H, et al. *(*2005). 'Heavy Metal Pollution Assessment in Surface Water Bodies and its Suitability for Irrigation Around the Nayevli Lignite Mines and Associated Industrial Complex, Tamil Nadu, India'. *Mine Water Environ* 24:155-161.

[9]. Ramulu K.N and Benarjee G (2013). 'Physico-Chemical factors Influenced Plankton Biodiversity and Fish Abundance – A Case Study of Nagaram Tank of Warangal, Andhra Pradesh, India'. *International Journal Life Sciences, Biotech & Pharm. Research*. Vol. 2, no. 2, ISSN 2250-3137.

[10]. Adeoye, PA., Musa, JJ. and Akinyemi, BA (2009). 'Design of Aerated Lagoon for Fish Pond Waste Water Treatment'. *Journal of Turkish*, Vol. 13, no. 3, p. 188-192.

[11]. Kudari V A, and Kanamadi R D (2007). 'Impact of Changed Trophic Status on the Zooplankton Composition in Six Water Bodies of Dharwad district, Karnataka state (South India)' .*Environmental monitoring Assessment* 144:301-313.

[12]. Thakur R.K, Jindal R, Singh U.B, et al. (2013). 'Plankton Diversity and Water Quality Assessment of Three Fresh Water Lakes of Mandi (Himachal Pradesh, India) with special reference to Planktonic indicators'. *Environmental Monitoring Assessment*.185:8355-8373.

[13]. Malik N, Biswas A.K, and Raju C.B (2013). 'Plankton as an Indicator of Heavy Metal Pollution in a Fresh Water Reservoir of Madhya Pradesh, India'. *Bull Environ Contam Toxicol*, 90:725-729.

[14]. Borics, G., Grigorzky, I., Szabo, S., et al. (2000). 'Phytoplanktons Associations in a Small Hypertrophic Fish Pond in East Hungary During a Change from Bottom-up to Top-down Control'. *Hydrobiologia* Vol. 424, no. 1-3, p. 79-90. http://dx.doi.org/10.1023/A:100.394.8827254.

[15]. Rajagopal T., Thangamani A., and Archunan G (2010). 'Comparison of Physico-Chemical Parameters and Phytoplankton Species Diversity of Two Perennial Ponds in Sattur Area, Tamil Nadu, India'. *Journal of Environmental Biology* 2010, 31(5)787-794.

[16]. Singh A.K, Mahato M.K, Neogi B, et al. (2010). 'Quality Assessment of Mine Water in the Raniganj Coalfield Area, India. *Mine Water Environ* 2010 29:248-262.

[17]. Shirke S, Phand S, DL Kruthika, et al. (2014). 'Plankton Diversity and Water Quality Assessment of Two Lakes in Vellore (Tamil Nadu, India.) with special Reference to Planktonic Indicators'. *International Journal of Advanced Technology in Engineering and Science* Vol. 2, Issue no. 9, ISSN (online): 2348-7550.

[18]. Kumar A. and Singh P. K. (2016). 'Qualitative Assessment of Mine Water of the Western Jharia Coalfield Area, Jharkhand, India'. *Current World Environment,* Vol. 11(1), 301-311.

[19]. Yadav H. L. and Jamal A. (2018). 'Assessment of Water Quality in Coal Mines: A Quantitative Approach'. *RASĀYAN J. Chem*. Vol. 11 No. 1, 46-522 ISSN: 0974-1496, e-ISSN: 0976-0083.

[20]. APHA (1998). Standard Method for the Examination of Water and Wastewater. 20th ed. American Public Health Association, Washington DC.

[21]. Needham J. G. and Needham P. R. (1977). *A Guide to the Study of Fresh Water Biology* : Holden – Day Inc. San Francisco, Constable Co. Ltd., London.

[22]. Mishra K. S. (1962). '*Records of the Indian Museum: An Aid to the Identification of the Common Commercial Fishes of India and Pakistan'*. Vol. 57, Parts 1-4. Govt. of India Press Pub., Calcutta.

[23]. Talwar P. K. and Jhingran A. G. (1991). '*Inland fishes of India and Adjacent Countries*. *Oxford & IBH Publication*, New Delhi'.

Websites:

http://dhanbad.nic.in

www.wikipedia.com